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10/759,858	01/16/2004	Henry A. Blauvelt	XPNT36NP	8740

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EXAMINER	
CONNELLY CUSHWA, MICHELLE R	
ART UNIT	**PAPER NUMBER**
2874	

DATE MAILED: 06/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary	Application No. 10/759,858	Applicant(s) BLAUVELT ET AL.
	Examiner Michelle R. Connelly-Cushwa	Art Unit 2874

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 May 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *21-24,34-43,64-67 and 77-119* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *40-43,83-86,95-100 and 111-119* is/are allowed.

6)☒ Claim(s) *21-24,34,35,37,39,64-67,77,78,80,82,87,88,90-92,94,101,102,104-107,109 and 110* is/are rejected.

7)☒ Claim(s) *36,38,79,81,89,93,103 and 108* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 May 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Applicant's Amendment filed May 4, 2005 has been fully considered and entered.

The indicated allowability of claims 21-24, 34, 35, 37, 39, 64-67, 77, 78, 80 and 82 is withdrawn in view of the newly discovered reference(s) to Blauvelt et al. (US 2004/0037342 A1). Rejections based on the newly cited reference(s) follow.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 21-24, 34, 35, 37, 39, 64-67, 77, 78, 80, 82, 87, 88, 90-92, 94, 101, 102, 104-107, 109 and 110 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hara et al. (JP 62-269907) in view of Blauvelt et al. (US 2004/0037342 A1).

Regarding claims 21, 34, 37, 87 and 91; Hara et al. discloses an optical apparatus in Figure 5(a), comprising :

- a semiconductor device substrate (301);
- a semiconductor optical device formed on the device substrate and including a device waveguide segment (302) terminating at a device end face; and
- an end-coupled planar optical waveguide (307) formed on the device substrate (301) at the device end face and end-coupled at its proximal

end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core (307) and a waveguide cladding (306);

- wherein a proximal portion of the end coupled waveguide includes a) waveguide cladding material between the device end face and a proximal end of the waveguide core, and b) waveguide core material on the device end face extending upward from the waveguide core away from the substrate.

Hara et al. does not disclose a reflective coating formed between the device substrate and at least a portion of the end-coupled waveguide.

Blauvelt et al. discloses a planar optical waveguide (120) formed on a substrate (102), the waveguide including a waveguide core (126) and a waveguide cladding (128), and a reflective coating (103) formed between the device substrate and at least a portion of the waveguide (120). Blauvelt et al. teaches that the reflective coating (103) is provided to prevent leakage of light propagating along the waveguide (120) into the substrate (102) to reduce loss (see paragraph [0062]). Therefore, one of ordinary skill in the art would have recognized the advantages of providing a reflective coating between planar waveguides and substrates that the waveguides are formed on to reduce loss. Thus, one of ordinary skill in the art would have found it obvious to incorporate a reflective coating formed between the device substrate and at least a portion of the end-coupled waveguide in the invention of Hara et al. to prevent leakage of light propagating along the waveguide into the substrate to reduce loss.

Hara et al. does not disclose a portion of the device end face that is curved in at least one dimension.

Blauvelt et al. discloses a semiconductor device coupled to a planar waveguide. Blauvelt et al. teaches that the practice of providing angled and/or curved end faces of semiconductor devices for reducing optical loss at a coupling region between the semiconductor device and a planar waveguide is known in the art (see paragraph [0063]). Therefore, one of ordinary skill in the art would have found it obvious to provide at least a portion of the device end face that is curved in at least one dimension to reduce optical loss at a coupling region between the semiconductor device and the planar optical waveguide in the invention of Hara et al., which increases optical end-coupling between the device waveguide segment and the end-coupled waveguide, relative to a substantially flat device end face.

Regarding claim 22; the reflective coating taught by Blauvelt et al. is a metal coating (see paragraph [0062]).

Regarding claim 23; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of claim 23 as applied above, except for the reflective coating comprising a dielectric coating. Blauvelt et al. does not explicitly state that a dielectric coating is used as the reflective coating, however, Blauvelt et al. does teach that any suitable reflective layer (metal, multi-layer, or other suitable reflector) may be equivalently employed (see paragraph [0062]). Thus, one of ordinary skill in the art would have found it obvious to incorporate any reflective coating, including a dielectric coating (multi-layer), between the planar waveguide and the substrate in the invention

of Hara e al. to prevent leakage of light propagating along the waveguide into the substrate to reduce loss, since it appears that the invention would perform equally well regardless of the particular reflective coating used.

Regarding claims 24 and 39; the end-coupled waveguide (307) of Hara et al. comprises a low-index planar optical waveguide.

Regarding claim 35; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of claim 35 as applied above, except for the curved portion of the end face being convex. One of ordinary skill in the art would have found it obvious to have the curved portion of the end face be convex in order to better collimate/focus light as desired at the coupling region between the semiconductor optical device and the waveguide segment in the invention of Hara et al.

Regarding claims 64, 77, 80, 101 and 106; Figure 5(a) of Hara et al. discloses a method comprising:

- forming a semiconductor optical device on a device substrate (301), the optical device including a device waveguide segment (302) terminating at a device end face;
- depositing waveguide cladding material (306) on the substrate and the device end face so that the cladding material substantially covers the device end face and forms a waveguide lower cladding layer;
- depositing waveguide core material over the lower cladding layer so as to form a waveguide core (307), deposited waveguide core material

extending upward from a proximal end of the waveguide core away from the substrate; and

- depositing waveguide cladding material (306) over the waveguide core material and lower cladding layer so as to form a waveguide upper cladding layer;
- wherein the lower cladding layer, the waveguide core, and the upper cladding layer form an end-coupled planar optical waveguide on the device substrate, end-coupled at its proximal end to the device waveguide through the device end-face;
- wherein the proximal portion of the end-coupled waveguide includes waveguide cladding material (306) between the device end face and the proximal end of the waveguide core (307);
- and wherein the method further comprises forming a multimode waveguide segment from the cladding material between the device end face and the proximal end of the waveguide core.

Hara et al. does not disclose forming a reflective coating between the device substrate and at least a portion of the end-coupled waveguide.

Blauvelt et al. discloses a planar optical waveguide (120) formed on a substrate (102), the waveguide including a waveguide core (126) and a waveguide cladding (128), and a reflective coating (103) formed between the device substrate and at least a portion of the waveguide (120). Blauvelt et al. teaches that the reflective coating (103) is provided to prevent leakage of light propagating along the waveguide (120) into the

substrate (102) to reduce loss (see paragraph [0062]). Therefore, one of ordinary skill in the art would have recognized the advantages of providing a reflective coating between planar waveguides and substrates that the waveguides are formed on to reduce loss. Thus, one of ordinary skill in the art would have found it obvious to form a reflective coating formed between the device substrate and at least a portion of the end-coupled waveguide in the invention of Hara et al. to prevent leakage of light propagating along the waveguide into the substrate to reduce loss.

Hara et al. does not disclose a portion of the device end face that is curved in at least one dimension.

Blauvelt et al. discloses a semiconductor device coupled to a planar waveguide. Blauvelt et al. teaches that the practice of providing angled and/or curved end faces of semiconductor devices for reducing optical loss at a coupling region between the semiconductor device and a planar waveguide is known in the art (see paragraph [0063]). Therefore, one of ordinary skill in the art would have found it obvious to provide at least a portion of the device end face that is curved in at least one dimension to reduce optical loss at a coupling region between the semiconductor device and the planar optical waveguide in the invention of Hara et al., which increases optical end-coupling between the device waveguide segment and the end-coupled waveguide, relative to a substantially flat device end face.

Regarding claim 65; the reflective coating taught by Blauvelt et al. is a metal coating (see paragraph [0062]).

Regarding claim 66; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of claim 64 as applied above, except for the reflective coating comprising a dielectric coating. Blauvelt et al. does not explicitly state that a dielectric coating is used as the reflective coating, however, Blauvelt et al. does teach that any suitable reflective layer (metal, multi-layer, or other suitable reflector) may be equivalently employed (see paragraph [0062]). Thus, one of ordinary skill in the art would have found it obvious to incorporate any reflective coating, including a dielectric coating (multi-layer), between the planar waveguide and the substrate in the invention of Hara e al. to prevent leakage of light propagating along the waveguide into the substrate to reduce loss, since it appears that the invention would perform equally well regardless of the particular reflective coating used.

Regarding claims 67 and 82; the end-coupled waveguide (307) of Hara et al. comprises a low-index planar optical waveguide.

Regarding claim 78; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of claim 78 as applied above, except for the curved portion of the end face being convex. One of ordinary skill in the art would have found it obvious to have the curved portion of the end face be convex in order to better collimate/focus light as desired at the coupling region between the semiconductor optical device and the waveguide segment in the invention of Hara et al.

Regarding claims 88 and 92; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of these claims as applied above, except for specifically stating that an optical coating is formed between the device end face and

the end-coupled waveguide. Anti-reflective optical coatings or coatings for reducing loss are commonly formed on end-faces of optical devices/waveguides and/or in between semiconductor devices and waveguides to avoid any unwanted reflections. Additionally, Blauvelt et al. suggests that structures and adaptations that includes anti-reflective coatings at end-faces or at faces between a semiconductive optical device and a waveguide are known in the art (see paragraph [0063]). Therefore, one of ordinary skill in the art would have found it obvious to form an anti-reflective optical coating between the device end face and the end-coupled waveguide to suppress unwanted reflections in the invention of Hara et al.

Regarding claims 90, 94, 104 and 109; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of these claims as applied above, except for specifically stating that the device end face is non-normal with respect to the optical propagation along the device waveguide segment. The practice of providing angled and/or curved end faces of semiconductor devices for reducing optical loss is well established in the art. Blauvelt et al. teaches that such a modification would have been evident to one of ordinary skill in the art (see paragraph [0063]). Therefore, one of ordinary skill in the art would have found it obvious to have the device end face be angled or curved (i.e. non-normal) with respect to the optical propagation along the device waveguide segment in the invention of Hara et al. to reduce optical loss.

Regarding claims 102 and 107; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of these claims as applied above, except for specifically stating that an optical coating is formed between the device end face and

the end-coupled waveguide. Anti-reflective optical coatings or coatings for reducing loss are commonly formed on end-faces of optical devices/waveguides and/or in between semiconductor devices and waveguides to avoid any unwanted reflections. Additionally, Blauvelt et al. suggests that structures and adaptations that includes anti-reflective coatings at end-faces or at faces between a semiconductive optical device and a waveguide are known in the art (see paragraph [0063]). Therefore, one of ordinary skill in the art would have found it obvious to form an anti-reflective optical coating between the device end face and the end-coupled waveguide to suppress unwanted reflections in the invention of Hara et al.

Regarding claims 105 and 110; the proposed combination of Hara et al. and Blauvelt et al. teaches all of the limitations of these claims as applied above, except for multiple optical devices being formed concurrently on a common device substrate wafer, and multiple corresponding end-coupled waveguides being formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates. It is common practice in the art to batch process multiple optical devices by forming the multiple devices and any integrated waveguides on a common device substrate wafer simultaneously and then dividing the common substrate wafer into multiple device substrates having a single device and corresponding integrated waveguide thereon to decrease manufacturing costs and increase the speed with which such optical devices are manufactured. Therefore, one of ordinary skill in the art would have found it obvious to form multiple optical devices concurrently on a common device substrate wafer, and multiple corresponding end-

coupled waveguides concurrently on the common substrate wafer, and divide the common substrate wafer into multiple device substrates to reduce manufacturing costs and decrease production time.

Allowable Subject Matter

Claims 36, 38, 79, 81, 89, 93, 103 and 108 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 40-43, 83-86, 95-100 and 111-119 are allowed.

The following is a statement of reasons for the indication of allowable subject matter: The prior art cited on attached form PTO-892 is the most relevant prior art known, however, the invention of claims 36, 38, 40-43, 79, 81, 83-86, 89, 93, 95-100, 103, 108 and 111-119 distinguishes over the prior art of record for the following reasons.

Regarding claim 36; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an apparatus as defined in claim 36, wherein the curved portion of the end face serves to increase reflective optical coupling of a device optical mode back into the device waveguide segment, relative to a substantially flat device end face in combination with the other limitations of the base claim.

Regarding claim 38; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an

apparatus as defined in claim 38, wherein the curved portion of the end face is limited in transverse extent so as to suppress higher-order device optical modes in combination with the other limitations the base claim.

Regarding claims 40-43 and 95-98; the claims are allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an apparatus as defined in claim 40, wherein the device end face includes an outwardly protruding portion extending along the substrate from a bottom portion of the device end face beneath a proximal portion of the end-coupled waveguide; and at least one layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing layer thickness together yielding a desired layer surface profile for at least one layer of the end-coupled waveguide in combination with the other limitations of claim 40. Claims 41-43 and 95-98 depend from claim 40.

Regarding claim 79; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 79, wherein the curved portion of the end face serves to increase reflective optical coupling of a device optical mode back into the device waveguide segment, relative to a substantially flat device end face in combination with the other limitations of the base claim.

Regarding claim 81; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 81, wherein the curved portion of the end face is limited in

transverse extent so as to suppress higher-order device optical modes in combination with the other limitations the base claim.

Regarding claims 83-86 and 111-115; the claims are allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 83, wherein the device end face includes an outwardly protruding portion extending along the substrate from a bottom portion of the device end face beneath a proximal portion of the end-coupled waveguide, and at least one layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding of the device waveguide and the decreasing layer thickness together yielding a desired layer surface profile for at least one layer of the end-coupled waveguide in combination with the other limitations of claim 83. Claims 84-86 and 111-115 depend from claim 83.

Regarding claim 89; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an apparatus as defined in claim 89, wherein the end-coupled waveguide includes a dual-core segment in combination with the other limitations of the base claim.

Regarding claim 93; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an apparatus as defined in claim 93, wherein the end-coupled waveguide includes a dual-core segment in combination with the other limitations of the base claim.

Regarding claim 99; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an

apparatus as defined in claim 99, wherein the waveguide core supports an optical mode substantially spatial-mode-matched with an optical mode supported by the device waveguide segment and the length of the multimode waveguide segment is chosen so as to result in substantially spatial-mode-matched end-coupling between the device waveguide segment and the portion of the end-coupled waveguide that includes the waveguide core in combination with the other limitations of claim 99.

Regarding claim 100; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious an apparatus as defined in claim 100, wherein the waveguide core supports an optical mode larger than an optical mode supported by the device waveguide segment, and the length of the multimode waveguide segment is chosen so that it functions as a mode expander for end-coupling the device waveguide segment and the end-coupled waveguide in combination with the other limitations of claim 100.

Regarding claim 103; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 103, wherein the end-coupled waveguide includes a dual-core segment in combination with the other limitations of the base claim.

Regarding claim 108; the claim is allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 108, wherein the end-coupled waveguide includes a dual-core segment in combination with the other limitations of the base claim.

Regarding claims 116 and 117; the claims are allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 116, further comprising, before depositing the waveguide core material, masking the lower cladding layer, leaving unmasked that portion of the waveguide cladding material covering the device end face, forming a substantially flat upper surface of the lower cladding layer and exposing an upper portion of the device end face by removing the unmasked portion of the waveguide cladding material until is about the same thickness as the lower cladding layer and thereby forms a portion thereof, and de-masking the lower cladding layer, wherein the upward-extending waveguide core material at the proximal end of the waveguide core is deposited on the exposed upper portion of the device end face in combination with the other limitations of claim 116. Claim 117 depends from claim 116.

Regarding claims 118 and 119; the claims are allowable over the prior art of record because none of the references either alone or in combination disclose or render obvious a method as defined in claim 118, wherein waveguide cladding material deposited on the device substrate and on the device end face is at least as thick as the device waveguide segment, and further comprising, before depositing waveguide core material, forming a substantially flat waveguide cladding material upper surface substantially flush with an upper surface of the device waveguide segment by removing waveguide cladding material by chemical-mechanical polishing, and forming a substantially flat lower cladding layer and exposing an upper portion of the device end face by removing waveguide cladding material by cladding-material-specific etching,

wherein the upward-extending waveguide core material at the proximal end of the waveguide core is deposited on the exposed upper portion of the device end face in combination with the other limitations of claim 118. Claim 119 depends from claim 118.

Hence, there is no reason or motivation for one of ordinary skill in the art to use the prior art of record to make the invention of 36, 38, 40-43, 79, 81, 83-86, 89, 93, 95-100, 103, 108 and 111-119.

Conclusion

Any inquiry concerning the merits of this communication should be directed to Examiner Michelle R. Connelly-Cushwa at telephone number (571) 272-2345. The examiner can normally be reached 9:00 AM to 7:00 PM, Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Rodney B. Bovernick can be reached on (571) 272-2344. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general or clerical nature should be directed to the Technology Center 2800 receptionist at telephone number (571) 272-1562.

Michelle R. Connelly-Cushwa

Michelle R. Connelly-Cushwa
Patent Examiner
June 2, 2005